A Precise Multi-Channel QDC FEE utilizing FPGAs as Discriminators and Delay Elements Based on the TRB3 as TDC and Readout Platform *

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A very compact 8 channel Front-End-Electronics for precise TDC and QDC measurements was developed with the focus on the readout of the HADES-Electromagnetic-Calorimeter PMTs. The measurement principle of the FEE is to convert the charges of the PMT signals into pulses, where the charges are encoded as the width of the pulses. The high precision is achieved by implementing a modified Wilkinson-ADC method, so actively discharging the integrated signal resulting in a fast crossing of the threshold. The lengths of the pulses are measured by the well established TRB3 platform [1], [2]. The circuitry of the FEE is based on the Come&Kiss principle, where analog electronics is used only for the amplification stage and integration, while the other tasks, e.g. discrimination, threshold settings, delay generation for discharging and the LVDS drivers, are implemented in an FPGA (see figure 1).

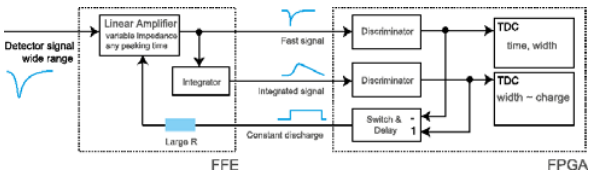

Figure 1: Schematic overview of the Come&Kiss TDC and QDC Front-End-Electronics.

This results in conceptionally simple electronics, hiding complex operations inside the FPGA. The developed FEE is very compact and the finished module is shown in figure 2, which can be directly attached to the TRB3 platform. The charge measurement precision (resolution of the system defined as $RMS/mean$ of the distribution) as a function of the measured charge has been determined with a pulser input signal and the uncorrected raw data is shown in figure 3. In beam measurements (with photons at MAMI in Mainz) with the FEE connected to lead glass ECAL modules show a comparable result in the determined energy resolution of the complete system as measured with an oscilloscope. The measurements are shown in figure 4.

References

[1] C. Ugur et.al, GSI Scientific Report 2013

[2] C. Ugur et.al, NoMe TDC Workshop - Perugia/Italy, 2013, `http://trb.gsi.de`

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Figure 2: The Padiwa-Amps1 FEE module implementing 8 channels of fast discriminators and precise charge to width conversion.

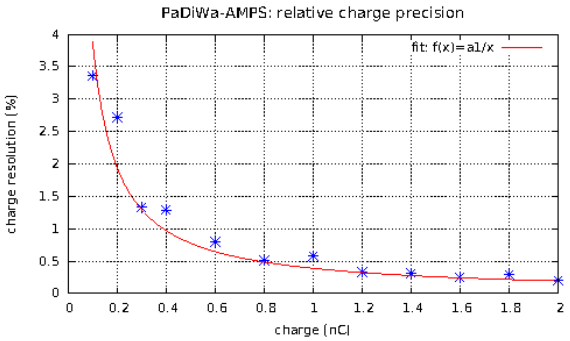

Figure 3: Relative charge measurement precision ($RMS/mean$) determined with a pulser.

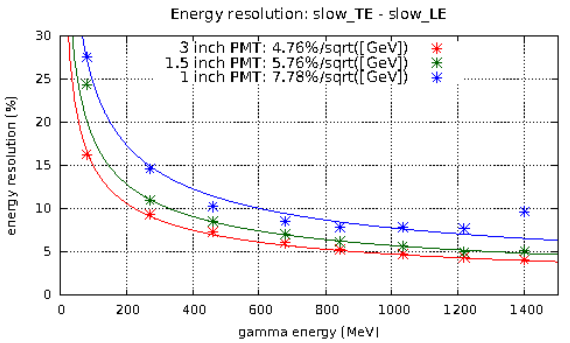

Figure 4: Energy resolution of a system with lead glass ECAL modules, different PMTs, Padiwa Amps as discriminator and QDC and a TRB3 as digitizer.

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